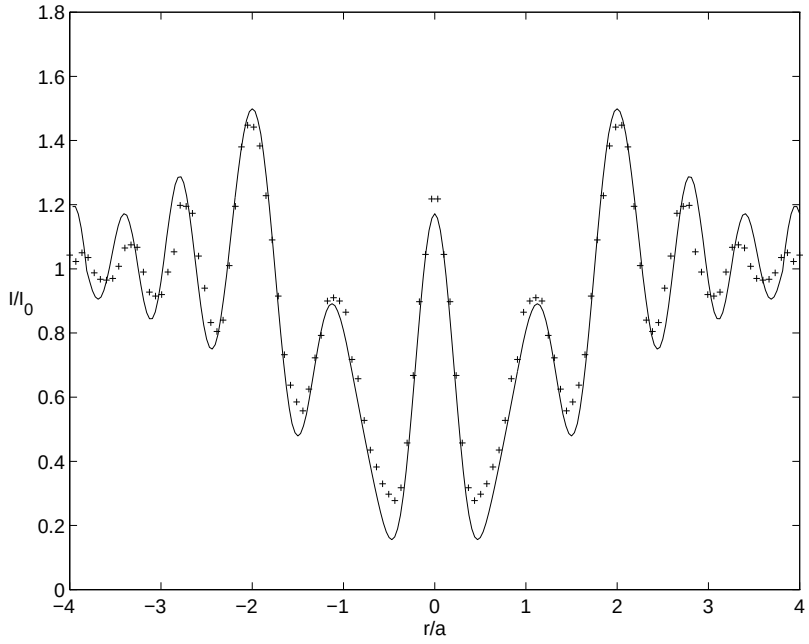
Technology Opportunity

Forward-Scattering Particle Image Velocimetry

Forward-scattering particle image velocimetry (FSPIV) is a method for obtaining three-dimensional velocity profiles in a seeded fluid by using partially coherent, forward-scattered light. There are several distinct advantages to this arrangement, including easily identified particle centroids and the possibility of simultaneously obtaining the fluid velocities in different planes without moving or scanning the optical apparatus. The essence of the technique is to correlate the scattered light that was collected with a transmitted light microscope by using either theoretical predictions or a series of calibration images. The technique requires using a high-density charge-coupled device (CCD) array camera and a personal computer; a method of digitizing the images from the CCD array is also required.

Potential Commercial Uses

- Measurement of two- and three-dimensional flows
- Determination of the effect of shearing flows on cell growth
- Measurement of flow in thin films



Scattering from a 7-μm-diameter spherical particle in oil at a fixed distance, d, from the best focus, where I/I_0 is the normalized intensity, r is the distance from the center of the particle, and a is the particle radius.

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Benefits

- Can be employed using any transmitted light microscope.
- Requires only a high-quality CCD camera connected to a personal computer.
- Can produce, in a microscopic field of view, both two- and three-dimensional measurements of a fluid flow with high accuracy.
- Does not require a moving optical component.

The Technology

Forward-scattering particle image velocimetry (FSPIV) uses the standard illumination source found in a good-quality, transmitted-light microscope. When appropriately adjusted, the light from this source becomes spatially coherent enough that the image of the light scattered from spherical seed particles contains interference fringes. This interference pattern changes in a predictable manner as the particle moves in and out of focus. By using an exact theoretical description of the light scattered by these particles, we can predict the particle's location precisely. By following the scattering as a function of time, we can predict the fluid velocity. The prediction relies on a comparison of the collected data with either a bank of theoretical images or experimentally obtained calibration images. Neural networks have been used successfully to perform the comparison.

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Key Words

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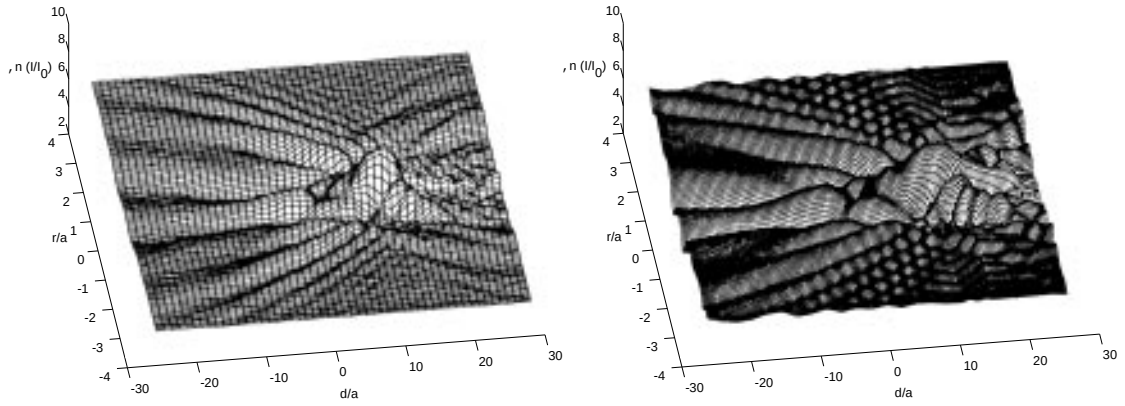

(a) Data. (b) Theory.

Scattering from a 7-μm-diameter spherical particle in oil at a range of distances, d, from the best focus, where I/I_0 is the normalized intensity, r is the distance from the center of the particle, and a is the particle radius.

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